

Pond – 378  
DOCUMENTATION  
Embankment

I. Reference Materials

The following reference materials will be used for the planning, design, and construction of embankment ponds.

- a. Technical Guide, Section IV, Practice Standard 378, Ponds
- b. Engineering Field Manual (EFM), Chapters 1, 2, 3, 4, 5, 6, 11, and 17.
- c. ND Supplement to Engineering Field Manual (NDSEFM), Chapters 2, 3, 4, and 11
- d. Agricultural Handbook 590, Ponds - Planning, Design, Construction
- e. Hydrology Manual for ND
- f. County Soil Survey Report
- g. ND Construction and Material Specifications for Conservation Practices
- h. Technical Release 62, Engineering Layout, Notes, Staking, and Calculations
- i. National Operation and Maintenance Manual
- j. National Engineering Handbook, Section 19, Construction Inspection

II. Planning and Site Investigation

The following information shall be obtained:

- a. Purpose (livestock, wildlife, irrigation, etc.)
- b. Pond size, volume, depth, etc. requirements
- c. Watershed characteristics
  1. Drainage area
  2. Watershed slope, flow length, T<sub>c</sub> (Time of Concentration)
  3. CN (Soil - Cover Complex Number)
  4. Base flow conditions
- d. Job approval authority
- e. Soils/geologic investigation
  1. Planned by individual with job approval.
  2. Conduct a preliminary screening of the site with information from the county soil survey report.
  3. Test hole logs and samples.
    - (a) Unified Soil Classification System
    - (b) Embankment centerline and offsets (when necessary)
    - (c) Emergency spillway centerline and offsets (when necessary)
    - (d) Borrow areas
    - (e) Reservoir areas (borrow and permeable layers)
    - (f) Groundwater and water for construction
  4. Sedimentation - Consult with geologist when investigation and analysis are necessary.
  5. Soil resistivity measurements when needed for the design of cathodic protection for buried metal pipe.
- f. Locations of overhead and buried utilities.

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III. Design Surveys

- a. Survey notes shall be kept in loose-leaf or bound field notebooks. The notes will be kept in a format similar to that shown in Technical Release 62, and Chapter 1, Engineering Field Manual.
- b. Embankment: The embankment foundation will be cross-sectioned at intervals sufficiently close to accurately define the earthwork volumes. In no case will the spacing between cross sections exceed 100 feet.
- c. Emergency Spillway: A profile along the centerline of the emergency spillway will be obtained for the purpose of spillway layout for hydraulic design. The need for cross sections will be determined by the person having job approval for the site.
- d. Reservoir Area: The need for a topographic survey of the reservoir will be determined by the person having job approval for the site. Reservoir surveys shall be performed when accurate storage volumes are needed for permits or for reservoir flood routing and when needed for identifying inundated areas. Reservoir surveys should extend to at least the top of the dam.
- e. Outlet Channel: A profile of the outlet channel will be surveyed for a minimum distance of 500 feet downstream of the embankment. The profile will be used for setting outlet elevations for principal and emergency spillways.
- f. Surveys shall include the locations of all affected utilities (buried or overhead).

IV. Design

The design of embankment ponds will be in accordance with Standard and Specification 378 Pond, Section IV, Technical Guide.

Where reservoir storage volume is considered in the design of the dam, refer to the user's manual for the DAMS2 computer program (TR-48), other approved pond design computer program, or North Dakota Hydrology Manual, Appendix C.

The following steps shall be followed for the design of embankment ponds where spillway capacity is based on peak inflow (i.e., reservoir storage volume is not considered in sizing the spillway).

- a. Delineate and measure drainage area on USGS Quad map, aerial photo, or other suitable map.
- b. Determine runoff curve number (CN) Use Forms ND-ENG-12 or ND-ENG-31 for computations.

References: 1) Hydrology Manual for ND, Chapter 2 and 3  
2) EFM, Chapter 2  
3) NDSEFM, Chapter 2

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- c. Determine average watershed slope and flow length from USGS Quad maps or field measurements.

References: 1) Hydrology Manual for ND, Chapter 5  
2) EFM, Chapter 2

- d. Determine required principal and emergency spillway design frequencies.

References: 1) Hydrology Manual for ND, Chapter 1, Table 1-7  
2) NDSEFM, Chapter 2, Table 2-2

- e. Determine required 24 hr. rainfall depths.

References: 1) Hydrology Manual for ND, Chapter 1, Fig. 1-2, thru 1-8  
2) NDSEFM, Chapter 2, Table 2-3

- f. Determine the required peak discharge rates by the procedures outlined on Forms ND-ENG-8 or ND-ENG-31.

References: 1) Hydrology Manual for ND, Chapter 5  
2) EFM, Chapter 2  
3) NDSEFM, Chapter 2

- g. Determine required permanent pool elevation in accordance with "Pond Size" requirements contained in the ND Technical Guide, Section IV, Practice Standard 378, Ponds.

- h. Size the principal spillway to pass the required design discharge.

References: 1) NDSEFM, Chapter 3  
2) Ohio Engineering Computer Programs

- i. Determine the minimum acceptable elevation of the emergency spillway crest as the higher of:

- 1) One foot above the crest of the principal spillway, or
- 2) The reservoir elevation required to pass the principal spillway design discharge.

- j. Size the emergency spillway to pass the required design discharge. The velocity in the emergency spillway exit channel shall not exceed the permissible velocity for the soil and cover types shown in the Tech Guide, Section IV, Practice Standard 378, Ponds.

References: 1) NDSEFM, Chapter 3 pp. 3S.41 thru 3S.56

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- k. Determine the minimum acceptable elevation of the top of dam as the higher of:
  - 1) One foot above the water surface in the reservoir with the emergency spillway flowing a design depth ( $H_p + 1$  ft) or
  - 2) A minimum depth of two feet between the emergency spillway crest and the top of dam.
- l. Record all pertinent data on Form ND-ENG-16, Hydraulic Data Sheet.

V. Construction Drawings and Specifications

At least 3 sets of drawings and specifications will be prepared and distributed to the cooperator, contractor, and cooperator's file. For most jobs, Forms ND-ENG-15A or ND-ENG-16B may be used. For more complex jobs, site specific drawings and other approved drawings will be used. In addition to drawings and specifications, the cooperator will be provided an O&M Plan.

Items to be included on the drawings:

- a. Location map showing the embankment, principal and emergency spillways, borrow areas, work limits (if needed), reservoir area, utilities, and any other necessary information.
- b. Typical cross section of the dam showing:
  - 1. Embankment top width, side slopes, berms, overfill requirements, and elevations
  - 2. Foundation stripping requirements
  - 3. Cutoff trench bottom width and side slopes
  - 4. Layout of the principal spillway if space permits. Otherwise, a separate detail of the principal spillway layout is required.
- c. Profile along centerline of the embankment showing:
  - 1. Original ground line and stationing
  - 2. Soils logs and groundwater
  - 3. Cutoff trench depth
  - 4. Locations, elevations, and dimensions of principal and emergency spillways
  - 5. Settled top of embankment and overfill (allowance for settlement)
- d. Profile along centerline of emergency spillway showing:
  - 1. Original ground line and stationing
  - 2. Soils logs and groundwater
  - 3. Finished grades for spillway
  - 4. Requirements for overexcavation and replacement with topsoil

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e. Details of the principal spillway shall include:

1. Details of inlet

- (a) Type (drop/riser, hood, weir box, etc.)
- (b) Material (corrugated metal, concrete, plastic, etc.)
- (c) Dimensions (diameter, height, stub locations, material thickness)
- (d) Special coatings (polymer coated pipe)
- (e) Footing/riser base (material, dimensions)
- (f) Details of drawdown pipe

2. Details of barrel

- (a) Material (c.m., concrete, plastic)
- (b) Dimensions (diameter, elbows, material thickness)
- (c) Special coatings

3. Appurtenances

- (a) Plunge pools/riprap
- (b) Pipe support (concrete, metal, timber)
- (c) Seepage control along pipe
  - (1) Filter and drainage diaphragm (Sand) - use is encouraged in place of antiseep collars.
  - (2) Antiseep collars - The number of collars shall be computed as

$$n = 0.075 \times l/v \quad \text{where:}$$

$n$  = number of collars

$l$  = length of barrel within the dam

$v$  = vertical projection of the collar

- (d) Cathodic protection when needed
- (e) Antivortex device on inlet
- (f) Trash rack on inlet

f. Construction notes - The drawings will include all notes necessary to clarify construction and material requirements for the job.

g. Quantities - Estimated quantities based on field surveys and design layout shall be shown on the drawings. All quantities shall be checked by another person.

h. Job approval - Drawings shall be signed by the designer, checker, and person with required job approval authority.

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- i. Specifications - Construction and material specifications shall be prepared for all embankment ponds. The following references shall be used:
  - 1. Construction Specification ND-9, Pond (Embankment)
    - (a) shall be used for small, simple sites
    - (b) shall include the following, as notes on the drawings or as Section 13, Construction Details of this spec.
      - (1) Moisture and compaction requirements for earth fill
      - (2) Details of the principal spillway
      - (3) Details of foundation or embankment drainage
      - (4) Details of concrete
      - (5) Details of vegetation
      - (6) Details of fencing
      - (7) Other site specific instructions to the contractor
  - 2. North Dakota Handbook of Construction and Material Specifications for Conservation Practices or National Engineering Handbook, Section 20, shall be used for more complex sites.
- j. Assist the landowner in completing applications for required state and federal permits (water rights, 404, etc.).

VI. Layout

Layout surveys will be recorded in loose-leaf or bound survey books. Survey notes will be kept in the format shown in the Engineering Field Manual, Chapter 1, and Technical Release 62. Centerline and slope stakes will be set for the embankment and emergency spillway. When necessary, centerline and grade/slope stakes will be set for the principal spillway and outlet channel.

VII. Compliance Checking - "As Built" Plans

Refer to the Engineering Field Manual, Chapter 17, and NEH-19 for guidance on methods of inspection and testing. NEH-19 contains inspection checklists covering all major items of work. Records of all materials and testing will be placed in the cooperator's file. As a minimum, as-built measurements should include:

- a. Cutoff trench centerline profile
- b. Principal spillway
  - 1. Location (station)
  - 2. Inlet and outlet elevations
  - 3. Lengths and dimensions as needed

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- c. Embankment
  - 1. Centerline profile
  - 2. Cross sections as needed (maximum cross section as a minimum - for larger dams, one approximately every 300 ft.)
- d. Emergency spillway
  - 1. Centerline profile
  - 2. Cross sections as needed (at least one on the level crest and one on the outlet channel)
- e. Miscellaneous
  - 1. Topsoil (area and depth)
  - 2. Seeding (area, species, etc.)
  - 3. Fencing (length, type, post spacing, etc.)

Record as-built measurements and quantities on Form ND-ENG-16A, ND-ENG-16B, or other appropriate drawings.

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Excavated

1. General

Complete appropriate parts of Form ND-ENG-17 (Stockwater Dugout Data Sheet) or ND-ENG-17a (Stockpond Restoration Data Sheet) for recording survey, design, layout, and yardage determinations.

2. Layout

- a. Record bench mark; describe and assign elevation.
- b. Record top and bottom dimensions, side and end slopes, and rod readings at dimension points; also a minimum of one rod reading on either side where spoil will be placed. Determine yardage from ND-ENG-17 or ND-ENG-17a.
- c. Record if fencing is required.
- d. Locate and log test holes.

3. Checking

- a. SCS checkout
  - (1) Check appropriate section of Form ND-ENG-17 or ND-ENG-17a.
  - (2) Survey and record on Form ND-ENG-17, ND-ENG-17a, or ND-ENG-52.
    - (a) Form ND-ENG-17 or ND-ENG-17a (use with 5% spot check).
      - 1) Centerline profile (cross section).
      - 2) Cross sections at ends of design bottom.
    - (b) Form ND-ENG-52 (do not use with 5% spot check).
      - 1) Partial cross sections showing end slopes.
      - 2) Partial cross sections showing side slopes.
    - (c) Berm width (both forms)
    - (d) Spoil height (bottom forms)
    - (e) Check yardage computations.
  - (3) Complete Form ND-ENG-17, ND-ENG-17a, or ND-ENG-52, including signature and date.
- b. Contractor checkout
  - (1) Check appropriate section of Form ND-ENG-17 or ND-ENG-17a.
  - (2) Review contractor completed Form ND-ENG-17, ND-ENG-17a, or ND-ENG-52 for completeness and compliance with design requirements and specifications.
  - (3) Check yardage computations.
  - (4) Initial and date form under contractor's signature.

\*In addition to the required 5% spot check, the district conservationist will determine need and spot check of each contractor operating in the district. He will implement procedures, schedule and assist in training of contractors in checkout procedures.



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1. Staking for Construction

All offset stakes shall be marked with the offset distance circled, i.e. 5 foot offset; mark 5' on stake as well as cut and other pertinent information.

2. Yardage Computations for Enlargement or Restoration of Excavated Dugouts

Yardage computations may be made by several methods. The following two methods are preferred:

a. Method 1

- (1) Determine the size of the existing dugout by taking at least eight shots around the perimeter of the hole, average the shots and subtract from HI to determine weighted top elevation. Take at least five shots in bottom of hole, average the shots and subtract from HI to determine weighted elevation of bottom. Difference in elevations is weighted depth. Determine an average top width and length and an average bottom width and length. Determine midwidth and midlength by

$$\frac{TW \text{ (Ave.)} + BW \text{ (Ave.)}}{2} = MW \text{ and } \frac{TL \text{ (Ave.)} + BL \text{ (Ave.)}}{2} = ML$$

- (2) Use prismoidal formula

$$\frac{(A_T + 4A_m + A_B)}{6} \times \text{weighted depth} = \text{volume cubic yards}$$

(27)

The front of Engineering Form 17 can be used.

- (3) Set new slope stakes and take shots 6 through 13 (Engineering Form 17), use weighted top elevation determined in Step 1 and subtract new design bottom elevation to determine Cuts 1 through 5. Compute yardage from dugout yardage tables.
- (4) Compute yardage actually moved by subtracting yardage determined in Step 1 from yardage determined in Step 2.

b. Method 2

- (1) Cross section existing dugout taking at least seven cross sections--one at each end, one halfway down each slope, one at bottom of end slopes, and one midway in bottom.

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- (2) Compute yardage by average and area\* method for existing dugout with ground line as straight from edge of hole to other edge on each cross section, except end ones which are zero end area.
- (3) Cross section newly designed dugout at ends and same locations as Step 1 plus ends of new bottom. Compute yardage for new dugout by average end area method\* using procedure in Step 2.
- (4) Determine actual yardage moved by subtracting yardage determined in Step 2 from yardage determined in Step 3.

\*Determine end area by double end area, planimetering, or other acceptable methods.